What is claimed is:

1.   A projection system having three color channels, one for each primary color, comprising:

a plurality of spatial light modulator (SLM) devices, one for each color
5   channel, each SLM capable of modulating light on a per pixel basis;

a main illumination source capable of producing light;

a plurality of secondary illumination sources each capable of producing light;

a plurality of optical power controlling devices for controlling the flux of
10   light produced by the secondary illumination sources;

an integrating device capable of integrating the light produced by the main illumination source and the secondary illumination sources;

a color separating and re-combining device capable of receiving the integrated light from the integrating device, separating the light into the color
15   channels, directing the light in each color channel to the corresponding SLM, and re-combining the modulated light from each SLM to form an image; and

a projection lens capable of receiving the image from the color separating and re-combining device and projecting the image,

wherein the addition of light from the secondary illumination sources acts
20   to control color variations in the image.

2.   The system according to claim 1, wherein the main illumination source and the secondary illumination sources each have an intensity distribution and the intensity distributions of the main illumination source and secondary
25   illumination sources are matched.

3.   The system according to claim 1, wherein there is a secondary illumination source for each color channel.

30 4.   The system according to claim 1, wherein the optical power controlling devices are controlled by using secondary optical power control signals.

5.   The system according to claim 4, wherein the secondary optical power control signals are computed by determining chromaticities of the primary colors using the main illumination source alone and then determining a required amount of light from each secondary illumination source needed to bring the resultant

5   mixture to a desired chromaticity for each primary color.

6.   The system according to claim 4, wherein the secondary optical power control signals are computed by the method comprising:

    a)   setting input image channel gains to maximum for all three primary

10   color channels;

    b)   setting the optical power of the secondary illumination sources to zero;

    c)   supplying a maximum white light optical power from the main illumination source;

15 d)   setting the optical power of the main illumination source to the desired display brightness;

    e)   supplying a first primary color input so that all the pixels of the first primary color SLM are driven to full brightness to produce a first primary color image;

20 f)   measuring the spectral energy distribution of the first primary color image;

    g)   repeating steps (e) and (f) for a second primary color input and a third primary color input;

    h)   computing tristimulus values for the primary color images;

25 i)   computing xy coordinates for the primary color image tristimulus values;

    j)   setting the optical power of the main illumination source to zero and supplying a full white input to the projector so that all pixels of all SLM devices are driven to full brightness to produce a full white

30   image;

    k)   setting the first secondary illuminating source alone to maximum power to produce a first secondary color image;

l)   measuring a spectral energy distribution of the first secondary color image;

m)   repeating steps (k) and (l) for a second secondary illuminating source and a third secondary illuminating source;

n)   computing tristimulus values for the secondary color images;

o)   computing xy coordinates for the secondary color image tristimulus values;

p)   finding on a first primary – secondary color vector between the first primary color image xy coordinate and first secondary color image xy coordinate a first xy coordinate that is closest to a first desired display primary color xy coordinate;

q)   computing a first secondary optical power control signal for the first secondary illumination source to produce the color corresponding to the first xy coordinate found in step (p);

r)   repeating step (p) for a second primary – secondary color vector between the second primary color image xy coordinate and the second secondary color image xy coordinate for an xy coordinate that is closest to a second desired display primary color xy coordinate and a third primary – secondary color vector between the third primary color image xy coordinate and the third secondary color image xy coordinate for an xy coordinate that is closest to a third desired display primary color xy coordinate; and

s)   repeating step (q) to compute a second secondary optical power control signal for the second secondary illumination source and a third secondary optical power control signal for the third secondary illumination source.

7.   The system of claim 6, wherein the method for setting the secondary optical power control signals further comprises:

a)   setting the secondary illumination sources to optical powers based on the secondary optical power control signals;

b)   supply a full white input signal; and

44

c)   adjusting the overall display brightness as required.

8.   The system of claim 6, wherein the secondary optical power control signals determined in steps (p) and (q) are computed by the formulas:

$$d = \frac{\left|(C2_y - C1_y)(C3_x - C1_x) - (C2_x - C1_x)(C3_y - C1_y)\right|}{\sqrt{(C2_x - C1_x)^2 + (C2_y - C1_y)^2}} \quad ;$$

$$\left|\overrightarrow{C1CM}\right| = \sqrt{\left|\overrightarrow{C1C3}\right|^2 - d^2} \quad ; \qquad k = \frac{\left|\overrightarrow{C1CM}\right|}{\left|\overrightarrow{C1C2}\right|} \quad ;$$

$$CM_x = \left[k*\left|C1_x - C2_x\right|\right] + C1_x \quad ; \qquad CM_y = \left[k*\left|C1_y - C2_y\right|\right] + C1_y \quad ; \text{ and}$$

$$\alpha C2 = \frac{k}{1-k} \quad ,$$

where:
C1 is the xy coordinate for the main source primary chromaticity
C2 is the xy coordinate for the secondary source chromaticity
C3 is the xy coordinate for the desired primary chromaticity
$\overrightarrow{C1C2}$ is the vector between C1 and C2
$\overrightarrow{C1C3}$ is the vector between C1 and C3
d is the shortest distance between C3 and $\overrightarrow{C1C2}$
$\overrightarrow{C1CM}$ is the vector along C1 to the perpendicular vector between $\overrightarrow{C1C2}$ and C3 with length d
k is the ratio of the length of $\overrightarrow{C1CM}$ to the distance between C1 and C2
CM is the xy coordinate for the point on $\overrightarrow{C1C2}$ that is nearest to C3
$\alpha C2$ is the amount of the color represented by xy coordinate C2

9.   The system of claim 7, wherein the overall display brightness is adjusted using a master brightness control circuit.

10.   The system of claim 9, wherein the master brightness control circuit comprises:

a master brightness control value;

a main illumination source optical power control value;

45

a main multiplier that calculates a main illumination source optical power command value from a product of the master brightness control value and the main illumination source power control value;

a first secondary illumination source power control value;

5   a first multiplier that calculates a first secondary illumination source optical power command value from a product of the master brightness control value and the first secondary illumination source power control value;

a second secondary illumination source power control value;

a second multiplier that calculates a second secondary illumination source

10   optical power command value from a product of the master brightness control value and the second secondary illumination source power control value;

a third secondary illumination source power control value; and

a third multiplier that calculates a third secondary illumination source optical power command value from a product of the master brightness control

15   value and the third secondary illumination source power control value.

11.   The system of claim 1, wherein each secondary illumination source has an associated adjustable dichroic filter, where the adjustable dichroic filters are capable of adjustment to change the angle of incidence with the respective

20   secondary illumination source in order to adjust color variations in the image.

12.   The system according to claim 1, further comprising a light mixing system for focusing the light produced by the main illumination source and the secondary illumination sources into the integrating device.

25

13.   The system of claim 1 wherein the main and secondary illumination sources are lamps.

14.   The system of claim 1 wherein each secondary illumination source

30   comprises a wavelength selecting filter.

46

15.   The system of claim 1 wherein the main and secondary illumination sources are incandescent sources.

16.   The system of claim 1 wherein the main and secondary illumination sources are light emitting diode (LED) array sources.

17.   The system of claim 1 wherein the secondary illumination sources are lasers.

18.   The system of claim 1, wherein the system is used in a multiple projection system and the image of the system is combined with at least one other image to form a composite image.

19.   In a projection system capable of producing a color image, the projection system having a spatial light modulator (SLM) for each of three color channels, one for each primary color, a method for adjusting the color of the image, the method comprising:

       providing light having a spectral energy distribution from at least one illumination source to a separating and re-combining device;

       controlling the spectral energy distribution of the light entering into the color separating and re-combining device without reducing the overall brightness of the image;

       modulating the controlled light with at least one spatial light modulator (SLM) to form an image; and

       projecting the image.

20.   The method according to claim 19, wherein the illumination source comprises a main illumination source and at least one secondary illumination source and the spectral energy distribution is controlled by adding light from at least one secondary illumination source.

21.   The method according to claim 20, wherein the amount of added light from the secondary illumination source is computed by determining the chromaticities of the primary colors using the main illumination source alone and then determining the required amount of light from the secondary illumination source

5   needed to bring the resultant mixture to a desired chromaticity for each primary color.

22.   The method according to claim 19, wherein there are three secondary illumination sources, one for each color channel.

10

23.   The method according to claim 21, wherein the spectral energy distribution of the total illumination is controlled by controlling an optical power of light from each secondary illumination source to achieve a desired chromaticity for each primary color.

15

24.   The method according to claim 20, wherein each secondary source has an associated adjustable dichroic filter allowing a resulting spectral energy distribution of each secondary source to be shifted toward longer or shorter wavelengths.

20

25.   The method according to claim 19, wherein the spectral energy distribution is controlled by an adjustable bandpass filter in between the illumination source and the separating and re-combining device, wherein the adjustable bandpass filter is capable of controlling the color spectrum so that the amount of each primary

25   color in the light entering the separating and re-combining device is controlled.

26.   The method according to claim 25, wherein the amount of each primary color in the light entering the separating and re-combining device is computed by determining the chromaticities of the primary colors with the adjustable bandpass

30   filter in a neutral position and then adjusting the bandpass filter to bring the resultant mixture to a desired chromaticity for each primary color.

27.   The method of claim 19, wherein the projection system is used in a multiple projection system and the image produced by the system is combined with at least one other image produced by at least one other system to form a composite image.

28.   A projection system having three color channels, one for each primary color, comprising:

a plurality of SLM devices, one for each color channel;

an illumination source capable of producing light;

a first adjustable bandpass filter capable of controlling the spectral energy distribution of light in at least one color channel;

an integrating device capable of integrating the light produced by the illumination source as filtered by the first adjustable bandpass filter;

a color separating and re-combining device capable of receiving the integrated light from the integrating device, separating the light into the color channels, directing the light in each color channel to the corresponding SLM, and re-combining the modulated light from each SLM to form an image; and

a projection lens capable of receiving the image from the color separating and re-combining device projecting the image,

wherein adjustment of the first adjustable bandpass filter acts to control color variations in the image.

29.   The system according to claim 28, wherein the adjustment of the first adjustable bandpass filter is computed by determining the chromaticities of the primary colors with the first adjustable bandpass filter in a neutral position and then determining an angle for the first adjustable bandpass filter in order to achieve the required amount of light of each primary color needed to bring the resultant mixture to a desired chromaticity for each primary color.

30.   The system according to claim 28, further comprising a second adjustable bandpass filter capable of controlling the amount of light in at least one color

49

channel, wherein adjustment of the first and second adjustable bandpass filters acts to control color variations in the image.

31.   The system according to claim 30, wherein the adjustment of the first and second adjustable bandpass filters is computed by determining the chromaticities of the primary colors with the first and second adjustable bandpass filters in a neutral position and then determining an angle for the first adjustable bandpass filter and an angle for the second adjustable bandpass filter in order to achieve a required amount of light of each primary color needed to bring the resultant mixture to a desired chromaticity for each primary color.

32.   The system according to claim 28, further comprising an illumination relay, the relay positioned in the light path between the integrating device and the separating and re-combining device, wherein the first adjustable bandpass filter is positioned within the relay.

33.   The system according to claim 28, wherein the projection system is used in a multiple projection system and the image produced by the system is combined with at least one other image produced by other system to form a composite image.

34.   A projection system having three color channels, one for each primary color, comprising:

a plurality of SLM devices, one for each color channel, each SLM capable of modulating light;

three illumination sources capable of producing light, wherein there is one illumination source for each color channel;

a plurality of optical power controlling devices for controlling the flux of light produced by the illumination sources;

an integrating device capable of integrating the light produced by the illumination sources;

a color separating and re-combining device capable of receiving the integrated light, having a spectral energy distribution, from the integrating device, separating the light into the color channels, directing the light in each color channel to the corresponding SLM, and re-combining the modulated light from

5   each SLM, to form an image; and

a projection lens capable of receiving the image from the color separating and re-combining device and projecting the image,

wherein the spectral energy distribution of the light entering into the separating and re-combining device is controlled to control color variation of the

10   image.

35.   The system according to claim 34, wherein the spectral energy distribution is controlled by controlling the optical power of light from each illumination source to achieve a desired chromaticity for each primary color.

15

36.   The system according to claim 34, wherein each illumination source has an associated adjustable dichroic filter allowing the resulting spectral energy distribution of each illumination source to be shifted toward longer or shorter wavelengths.

20

37.   The system according to claim 34, wherein the projection system is used in a multiple projection system and the image produced by the system is combined with at least one other image produced by at least one other system to form a composite image.

25

38.   The method according to claim 22, wherein each secondary source has an associated adjustable dichroic filter allowing a resulting spectral energy distribution of each secondary source to be shifted toward longer or shorter wavelengths

30